Girls Can be Engineers too! Challenge

Welcome to the Girls Can be Engineers too! Challenge Badge. I have created this badge as part of my Queen's Guide Award to encourage more girls to consider a career in engineering. I hope that you enjoy it.

In 2018, only 12.37% of engineers in the UK were female, however this is increasing and 42% of girls aged 14-16 said they would consider a career in engineering.

This pack has been designed to show girls how exciting and varied the world of engineering can be, and hopefully inspire them to consider it as a future career.

This badge is aimed at all sections, however, please feel free to adapt the challenges for your unit's needs.

To complete the badge your unit should complete one activity from the introduction section, then one activity from any four of the engineering sections, finishing with one activity from the conclusion section.

The badge covers activities designed to introduce girls to six different types of engineering:

- Civil Engineering
- Electrical engineering
- Mechanical engineering
- Chemical engineering
- Aerospace engineering
- Software engineering

The introduction and conclusion activities are designed to show girls the endless possibilities in engineering, encourage them to investigate other types or engineering and empower them to feel that they could be a female engineer in this currently male dominated industry.

If you feel comfortable please consider discussing engineering careers with your unit as you progress through the challenges. This can include the types of careers available, and what role that each engineer may take in the real world. I have included some information with each section to help, but please feel free to contact me if you have any questions.

Any profits from this badge will be going towards our unit funds.

Thank you, and I hope that you enjoy the badge,

Danielle

Contents

The Challenges

The next two pages will give a brief outline of the challenges. Instructions for each activity are found in the next section. Remember you need to do one introduction, choose one activity from four different engineering types, then one conclusion challenge.

Introduction Challenges

Discussion - Discuss what you know about engineering already, what would you like to find out?

Which engineer? Game - Which engineer does what? Play this game to decide

What is engineering really like? - Invite an engineer to your unit and find out what it is like to be an engineer

Famous Female Engineers Bingo – Play this game of bingo and find out about female engineers from past and present

Civil Engineering

Marshmallow and Spaghetti Skyscrapers – test your design skills and build the tallest and strongest tower that you can. Then test it against the elements!

Paper Bridges – Test your construction skills and build a bridge from paper. Will it be able to hold a cup of water?

Sewage Works! – Civil engineers design and maintain a wide range of infrastructure. Try to make your own sewage works using marbles and cardboard tubes.

Houses in Natural Disasters – Design your own house that will survive as many natural disasters as possible.

Electrical Engineering

Wire a Plug – Learn to wire an electrical plug used in everyday household appliances.

Lemon Batteries – Use a lemon to make a battery and use it light up an LED!

Moving Water – Create your own static electricity with a balloon and use it to move water!

Circuit Pairs – Electrical circuits contain many different components. Each component is drawn with a specific symbol, test your knowledge with this game of pairs.

Mechanical Engineering

Bottle Top Gears – Turn bottle tops into gears. Can use one to make the others turn?

Recycled Cars – Start with recyclable materials and build a car to run down a ramp. How far will it go?

Bike Wheel Changeover – Learn to change a wheel on a bicycle and understand how gears can be used to transfer forces!

Water Wheels – Build your own water wheel and investigate how they first used water to power factories and mills!

Chemical Engineering

Material World- Different materials have different properties, gather a range of household items, and test their differences! Which one would be the best for each job?

Ooo… it's Oobleck - Oobleck is a non-Newtonian fluid made from cornflour and water. Make your own Oobleck and test its weird and wonderful properties.

What's Left Matters Too! - Chemical engineers don't just create new substances but consider how the waste products can be used too. Gather some household waste and give it another use and save it from the landfill.

Ice Melting - Try using different substances to melt ice, which will melt the ice the fastest and why?

Aerospace Engineering

Paper Aeroplanes - Build a range of paper aeroplanes and test how far they can travel. Which are more aerodynamic?

Egg Parachute - Build a parachute and container to protect your egg during a fall. Will it land safely?

It's Rocket Science - Build a rocket and use straw to see how high you can launch it into the air!

Balloon Hovercraft - Use a party balloon and a CD to build a hovercraft. Then see who's will travel the furthest?

Software Engineering

Program a leader - Challenge you unit to write instructions for a seemingly simple task. Will they make them clear enough to follow?

Flowchart of Life - Learn the basic block used in flowcharts, and create one that explains the steps in a daily task

Code for a Walk - Learn the basic structure of code, then write code for a walk around your local area

Code is all around - Code doesn't just exist in computers, it's all around us. Go for a walk and see how many you can find.

Conclusion Challenges

Discussion - Discuss what your unit has discovered whilst completing the badge. Has their opinion of engineering changed?

Encourage others - Challenge you unit to share what they have learnt with others. Maybe even encourage other to complete the badge too!

You mean there's more?! - Engineering doesn't just stop at the six types that this badge covers. Encourage your unit to discover another type or a career in engineering that appeals to them.

Engineering Superpowers - Engineers need lots of different skills, test some of these skills in each of these mini challenges

Introduction Challenges

The aim of the introduction section is to introduce your unit to engineering as a career and give some context to the activities that will follow. There are four options for this section:

1. Discussion
2. Which engineer? Game
3. Invite an engineer into your unit
4. Famous Female Engineers Bingo

Discussion

You can start this badge with a discussion, try to introduce different types of engineering, and what a job in engineering may be like. You can use the facts included in the resources and ask the girls questions such as:

- What do you think an engineer does?
- Can you name any types of engineer?
- Why do you think that the percentage of female engineers is so low?

Which engineer? Game

This game will help to introduce different types of engineering to the girls and get them to start thinking about the different types of engineering.

1. Choose the four types of engineering that you will be completing activities from for the rest of the badge. These are:
    - Civil Engineering
    - Electronic engineering
    - Mechanical engineering
    - Chemical engineering
    - Aerospace engineering
    - Software engineering
2. Then write them on paper and display one in each corner of the room.
3. Use the engineering descriptions so that the girls understand what type of engineering covers.
4. Ask the girls to stand in the middle of the room.
5. Call out a different item from the list in the resources that is designed or maintained by engineers.
6. The girls should then run to the type of engineering that they think applies.
7. If they think that more than one applies, they can stay between two corners or if they were not sure they can stay in the middle.
8. Repeat the game covering the different types of engineering.
9. You may also want to include examples from the other two sections, to show the girls that engineering is so varied and not restricted to the four types that you have used.

After you have repeated the game covering different types of engineering you can discuss how the girls found the game.

- Was it hard to choose between the different types of engineering?
- Did you know that there could be so many different types of engineering?
- Were any categories quite similar?

What is engineering really like?

You may want to start the badge by inviting an engineer into your unit. They could share their experiences with the unit and may be willing to give their input on some of the activities.

Don't worry if you don't know anyone, the Women's Engineering Society has a register of female engineers who are prepared to come to units and encourage more girls into engineering.

https://www.wes.org.uk/register

Famous Female Engineers Bingo

This activity will introduce the unit to different female engineers who have had an influence on our lives today. The girls can play in four to six groups, or individually if you wish.

1. Separate your unit into 4-6 groups.
2. Print out the bingo cards and give one to each group.
3. Explain to the girls about each different type of engineering so they are familiar with each engineering type. You can use the descriptions in the resources, which can either be read out or handed out with the bingo sheet.
4. Then call out the different types of engineering at random, one by one.
5. If a group has an engineer that fits into that sector, they can fill in their bingo card and share the work of that engineer with their group.
6. The first group to fill in their whole sheet wins.

Civil Engineering

Civil Engineers design and build infrastructure. This includes roads, bridges, water systems and sewage works. They apply the laws of Physics to make sure that they're designs are safe and will do the job that they have been designed for. For example, will the bridge be safe and will it hold the weight of people and cars, or when it rains will the water system be able to cope with the larger amount of water.

This section has four activities that try to replicate the design tasks completed by civil engineers:

1. Marshmallow and Spaghetti Skyscrapers
2. Paper Bridges
3. Sewage Works!
4. Houses in Natural disasters

Marshmallow and Spaghetti Skyscrapers

Civil engineers will work with architects to make sure that any building that they design are safe and will stand up to high wind without topping over. In this challenge each group will aim to build the strongest and tallest skyscrapers as possible. You can make this challenge easier or harder by changing the amount marshmallows and spaghetti given to each group.

You'll need:

- Marshmallows
- Spaghetti
- Tape measure – to measure the height of each tower
- Fan - to test the stability of each tower

What to do:

1. Split the unit into groups and give each group a half a bag of marshmallows and half a pack of spaghetti.
2. Give each group 20 minutes to build the strongest and tallest tower.
3. Once time is up, measure the height of each tower.
4. Then it's time to test their stability. Aim the fan and at the tower. Then turn it on and increase the speed (if possible) until the tower topples over.

- Which towers were the strongest?
- Which part of their design made them more stable?
- Which was easier to make a tall tower, or a stable tower?

Tip:

- Instead of using squares or rectangles, try using triangles. They're much stronger and won't rock side to side.

Paper Bridges

Civil Engineers will also design bridges. This activity will encourage you unit to use their imagination but also use their problem solving to make the most stable bridge. Your unit can either complete this individually or in groups.

You'll need:

- A4 paper
- Scissors
- Tape
- Cup of water

What to do:

1. Position two tables about 30cm apart.
2. Each group/ individual needs to build a bridge that crosses the gap between the two tables, using the paper, scissors and tape.
3. Test each bridge by placing a cup of water at the centre and see if it can hold the weight.

Tip:

- Think about how best to use the paper. Which is stronger rolling the paper or folding it? Are you going to use one layer of paper or more?

Sewage Works!

Civil engineers don't just build towers and bridges, they also build a wide range of infrastructure such as roads, dams and even sewage systems. For this activity your unit will try to make their own sewage system for a street of six houses.

You'll need:

- Lots of cardboard tubes
- Tape
- Marbles
- Water
- Scissors

1. Place six cups of water spaced out on a table. In two rows of three, like a street, with space for the 'sewage' system in between.
2. Place four marbles in each cup of water.
3. Provide each group with a selection of the tubes.
4. Each group must fit the tubes together to make a pipe system, that will collect all of the water and marbles into a bucket at the bottom without leaking!
5. Each house will need its own pipe into the main system.
6. They may need to cut holes in the tubes to fit them together or slot them inside of each other.
7. Once each group is ready test the system by pouring each cup down its 'sewage' pipe and see if the 'sewage' collects into bucket at the bottom!

- Did the water flow as you expected?
- Did you manage to stop any leaks?

Houses in Natural Disasters

When designing a building it must be able to cope with the local weather, this is especially important in areas that may be faced with natural disasters. For example, houses may be built on stilts in areas prone to flooding or tsunamis, so that water does not enter the main living space. Or buildings have deeper foundations in areas that may have earthquakes.

Challenge your unit to design a house that can cope with as many different natural disasters as possible. This could include Hurricanes, Earthquakes, Tsunamis and Wildfires. Ask them to think about how to make the building as strong as possible.

To extend the activity, your unit could then have a go at building their design from recyclable materials.

You could use:

- Shoe box or cereal box for the main structure of the house
- Cardboard to add features such as a roof
- Cardboard tubes for pillars or foundations
- Plastic containers for windows

You might also need

- Scissors
- Tape
- Glue

Electrical Engineering

Electrical Engineers work with electricity. Electricity is transferred by the movement of electrons, through materials. Once electrons can move around a complete circuit, electricity will flow. Electrical Engineers will design and work with electrical components, ranging from a new kettle to electric cars!

This section contains four activities which will introduce you to electrical engineering:

1. Wire a plug
2. Lemon batteries
3. Make an Electromagnet
4. Circuit pairs

Wire a Plug

We use plugs every day without thinking, they are simply plugged into the socket and we forget about them. In this challenge encourage your unit to take a plug apart and put it back together to understand what goes on inside.

You'll need:

- Household appliance or three pin plug
- A selection of screwdrivers
- The instructions (included in the resources)

Tip: If you do not have any plugs that you would like your unit to take apart, you could ask at your local tip. They might have some household appliances that you could cut the cable from.

Lemon Batteries

Batteries use a chemical reaction to supply electricity. Use this activity to turn lemons into batteries and show your unit how the first batteries worked.

You'll need:

- One lemon
- One low voltage LED
- One galvanised/zinc nail
- Two copper wires

1. Start by pushing down on the lemon and rolling it on the surface. You need to release some of the juices inside, the lemon should be soft, but be careful not to break the skin.
2. Next push one nail into the left side of the lemon. You want to push about three quarters of the nail in, but don't break the skin on the other side.
3. Push one copper wire about 2cm into the right side of lemon, then attach the other wire onto the end of the nail.
4. Then connect the LED. An LED has two leads, the longer lead is the positive wire this should be connected to the copper wire that goes directly into the lemon, whilst the shorter wire should connect to the lemon. To make each connection twist the wires together, so that they don't come apart.

5. Once connected the LED should light up. If your LED doesn't light up the first time, you can try using more lemons by connecting them in parallel, to increase the voltage from your lemon batteries.
    - Put your lemons in a line, so that all the nails are on the left-hand side.
    - Then connect the lemons, so that the copper wire on the right connects to the nail of the next lemon and keep going until you get to the end of the line.
    - Then connect the wire from the nail of the first lemon and the wire from the last lemon to the LED as before and watch the LED glow.

What's happening?

Lemons contain citric acid, which reacts with the zinc in the nail. This process is called oxidation, the acid causes the zinc to release electrons. The electrons can move through the lemon juice (which acts as an electrolyte), to the copper wire. The copper wire conducts the electricity to the next lemon or LED.

This is very similar to the first electrical battery that was invented in 1800 by Alessandro Volta. Zinc and copper disks were stacked on top of one another, with brine soaked felt sandwiched between each layer. The brine reacted in the same way as the lemon juice with zinc. When the battery was connected to a circuit, an electrical current flowed from one end of the stack to the other then around the circuit.

An LED is a light emitting diode when electrons pass through the LED it lights up. It is important to connect it the correct way, as it will only let electrons through in one direction.

Moving Water

Electricity is the transfer of charge by the movement of electrons. When we use electricity, the electrons move around the circuit. Static electricity is caused when the electrons don't move, instead a surface becomes positively or negatively charged. Explain to your unit how charge can be transferred from one side to the other and use static electricity to move water.

You'll need:

- Balloon
- Tray of water or tap

1. Blow up the balloon and tie the end with a knot.
2. Rub the balloon against your hair until it starts to stick on the balloon as you move the balloon away from your head. You've now built-up static electricity on the balloon.
3. **If you're using a tray of water** – Fill the tray with water so that it is about half a centimetre deep. Hold the balloon just over the water's surface but not touching. You should see the water rise up towards the balloon.

If you're using a tap – Turn the tap on so that the flow of water is as slow as possible. Move the balloon towards the running water. You should see the water bend towards the balloon.

What's happening?

When you rub the balloon on your hair, electrons from your hair are rubbed off and collect on the balloon. The surface of the balloon becomes negatively charged, whilst your hair becomes positively charged. Opposite charges are attracted to each other, so as you pull the balloon away, your hair wants to stay with the balloon.

Water contains positively charged molecules, so as the balloon is held towards the water, the water is attracted to the negatively charged balloon, causing it to move!

Circuit Pairs

Electrical circuits are drawn using lots of different electrical symbols. Each component has its own symbol, that is used by engineers all over the world. This helps electrical engineers to understand how electrical devices work and how to fix them. Challenge your unit to test their own knowledge of electrical symbols with this pairs game.

If your unit is unfamiliar with all of the circuit symbols you could start by pairing the ones that you know as a group, before revealing them all and playing the pairs game.

Playing cards with or without the symbol names are included in the resources, so that you can make the game easier or harder.

Mechanical Engineering

Most things that move have at least one mechanical part, such as gears or levers. Mechanical engineers will design, improve, or maintain mechanical systems such as car engines, or even lifts and air conditioning units. Mechanical engineering is one of the broadest types of engineering, the next four activities will help to introduce your unit to a small part of mechanical engineering.

1. Bottle top gears
2. Recycled Cars
3. Bike Wheel Changeover
4. Water Wheels

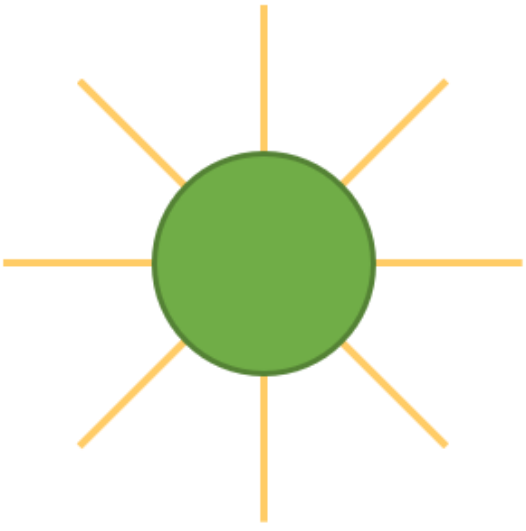
Bottle Top Gears

Lots of mechanical systems use gears to transfer a turning force from one area to another. Challenge you unit to make their own gears and use one to turn the others. You can make as many gears as you would like, but three can be a good number to start with.

You'll need:

- Bottle tops of different sizes
- Lollipop sticks (4 for each gear)
- Strong glue
- A piece of Cardboard
- Scissors

1. First you need to make your gears. For your gears choose your largest bottle tops.
2. Carefully cut each of the lollipop sticks in half.
3. Then glue the flat end of the lollipop sticks onto the bottle tops, the lollipop sticks act as the gear's teeth. Each bottle top should have 8 teeth, spread evenly around the bottle top, so that it looks like the image below.



4. Once you've made all of your gears, decide where you would like them to go on your cardboard, so that one can turn the others.
5. Remember where you placed them, then glue some smaller bottle tops in their place. Your gears will rest on these bottle tops, so that they can move freely.
6. Place your gears on to the bottle tops and see what happens when you turn one.

7. Try making more bottle tops with different length lollipop sticks or rearranging your gears.

    - What happens when the lollipop sticks are shorter? Is it easier of harder to turn the gears?
    - How many gears can you get to turn at once? (there may be limitations depending on the strength of your glue)
    - When you add more gears, is it easier or harder to turn the first one?
    - What happens if you change the number of teeth (lollipop sticks) on each gear? Can you make a gear with less teeth turn a larger gear with more teeth?

What's happening?

Gears are wheels with teeth that slot into one another. When two gears are placed next to each other, they can make each other turn. The teeth interlock, as the teeth of one gear moves it forces the other to turn as well!

Increasing the size of the teeth will make the gears easier to turn. If you think of a door hinge, pushing a door closed next to the hinge, is hard, but pushing it on the other end of the door is easy, this is because we are further away from the centre of rotation (hinge). The gears are easier to turn because the teeth interlock and push each other further from the centre of the gear, which is the centre of rotation!

Recycled Cars

Mechanical engineers will have had a huge role to play designing and building cars, whether this is designing the gearbox, or the machines that build the car. Challenge your unit to build their own moving cars out of recyclable materials.

You'll need:

- A selection of recyclable materials (such as boxes, bottle tops, paper straws, milk bottles, tubes)
- A wooden board or ramp
- Tape
- Scissors

After building their cars, set up the wooden board or ramp. Test each car by pushing it from the top of the ramp and see how far they can travel.

- Whose car went the furthest?
- Did any designs work better than others?
- Would it be possible to build a car that could steer?

Bike Wheel Changeover

Gears and pulleys are used in lots of systems to transfer force from one place to another. One place where this is seen in everyday life is on a bicycle, the cyclist turns the pedals which turns the gears, moving the chain, which turns the bike wheels causing the bike to move forwards.

Bring a bike to your unit and show your unit how to change a bike wheel, then let them have a go. This a great way for them to understand how gears work, but also get hands-on experience using tools.

What's happening?

As a cyclist pedals, they transfer an amount of force from their legs to the back wheel. Most bikes contain a set of gears attached to the back wheel, changing the size of gear that is used changes how the force is distributed and how it easy it can feel to pedal up that hill!

If the back gear has half the number of teeth of the pedal gear, the back wheel twice every time that the pedal gear rotates once. This means that the back gear will turn twice as fast but the force from the cyclist pedalling will be spread over two rotations. This can be useful when a cyclist cycles on a flat surface, less force is required to keep going forwards, so the bike can go faster. If the back gear has double the number of teeth as the pedal gear, the back wheel will only complete half a rotation, every time that the cyclist turns their pedals. This means that the force from the cyclist is spread over only half a rotation. More force will be applied per distance travelled along the road, making it easier for the cyclist to climb the hill!

Water Wheels

The first water wheel was used in the roman times, Vitruvius, a Roman Engineer used running water to turn the wheel to grind gains and supply water to villages! Water wheels have since been used in mills, to transfer the energy from running water to mechanical energy that could power the mill. Challenge your unit to build their own water wheel and investigate how it works.

You'll need:

- Cardboard or two paper plates
- Scissors
- Disposable cups
- Split pins
- Wooden skewer
- Water
- Bucket

Testing the water wheels can be wet, so you might want to do it outside, or you can use dried beans as an alternative to water!

1. If you are using cardboard start by cutting out two large circles of the same size.
2. Cut a hole in the centre of your circle or paper plate (your skewer will go through this hole later)
3. Carefully make two holes in the side of each cup, one opposite the other.
4. Use the split pins to attach the cups around the edge the circles. The cups should point outwards and be sandwiched between the two circles.
5. Then carefully push the skewer through the two holes that you made earlier!
6. Then you're ready to test your water wheel! Pour water onto the wheel whilst someone else holds the skewer, and watch it turn.

    - What happens if you pour the water from different heights? Does the wheel move faster or slower?

Chemical Engineering

Chemical engineers work with lots of different materials and chemicals, helping to design better methods to manufacture them, or new ways to use them.

This section has four different activities to help you to become more familiar with the world of chemical engineering:

1. Material world
2. Ooo… it'd Oobleck
3. What's left matters too!
4. Ice Melting

Material World

Chemical engineers will choose materials based on their properties, each has its advantages and disadvantages for each job. Gather a range of different items or ask your unit to find them at home or your meeting place.

Then compare each item:

- Do they sink or float in water?
- Are they hard or soft?
- Would they break if you dropped them?
- Is the surface smooth or rough?

Next ask them to choose the item that would be the best for a range of tasks, then ask them why they have chosen this one, which qualities make it best for the job?

Example tasks could be:

- Hammering a nail into a board
- Saving someone from a river
- Drying up dishes
- Keeping something dry

If completing this activity as a large group, you could lay each item on the floor and ask each girl to stand behind the object that they think would be best.

Ooo… it's Oobleck

Some chemical engineers will create or work with new materials, testing their properties and finding new uses for them. Oobleck is a non-Newtonian fluid, this means that it doesn't behave like a normal liquid or solid. It will run through your fingers but if you hit it, it will behave like a solid! Have a go at making Oobleck with your unit and test it for yourself!

You'll need:

- Cornflour
- Water
- Food colouring (optional)
- Mixing bowl
- Mixing spoon
- Protection for the worktop (it can be very messy!)

1. Measure one part water to two parts cornflour and start with the water in the mixing bowl.
2. Slowly add the cornflour to the water, making sure that it is fully mixed in before adding the next bit.
3. Once all of the cornflour is fully mixed in, you've made Oobleck, if you'd like to change its colour you can add food colouring at this stage.
4. The Oobleck should be a gloopy liquid, if you pour if from a spoon it should run off like water but if you hit it with the back of a spoon the surface will become hard and behave like a solid.

Encourage your unit to experiment with the Oobleck and try different things with it.

You can:

- Squeeze it in you hand, then feel it melt as you release your grip
- Jab a finger onto the surface then relax and let your finger sink in
- Roll it into a bouncy ball and see it bounce
- Make a puddle then drag your fingers through it

What's happening?

When the cornflour is mixed into the water, starch particles are suspended in the water. When pressure it applied to the Oobleck, such as hitting the surface, the starch particles are forced together, and it acts like a solid. However, when something moves slowly through it the starch particles have time to move out of the way and the Oobleck behaves like a liquid.

Did you know?

Oobleck is named after green rain that falls as liquid then becomes a solid when it hits the ground, in Dr. Seuss's book Bartholomew and the Oobleck!

What's Left Matters Too!

Chemical engineers don't just consider how best to make a substance, but also, its effect on the environment and the waste products that are produced in the process. We create waste products every day, whether this is waste plastic packaging or food scraps from preparing a meal. If the waste products can't be reduced, Chemical engineers will design ways to collect it, then find a purpose for the waste.

In this activity gather a range of household waste and ask your unit to consider different ways to use it. Will it solve an everyday problem, or replace an item that produces further waste? Then encourage your unit in teams to create one of their designs and see if it works.

You'll need:

- Range of household waste
- Tape
- Scissors

Ice Melting

Chemical engineers will look for new ways that we can use chemicals to solve everyday problems. Each winter ice can form on our paths and roads making them slippery and difficult to walk on. Give your unit a range of different substances and see which one would be best to melt the ice!

You'll need:

- Ice cubes (one for each substance plus one extra)
- Cups (one for each ice cube)
- Various household substances such as
    - Salt
    - Vinegar
    - Sugar
    - Bicarbonate of soda

1. Put one ice cube in each cup.
2. Then add each substance into one cup, leaving one ice cube alone, and give them a stir.
3. You want to make this experiment a fair test, so make sure to add the same amount of each substance and stir each ice cube the same amount (even the one with nothing added).
4. Then wait to see which one melts first. Try to guess which one you think it will be. Were you right?

- What else do you think could be done to melt the ice?
- What if you wanted to stop the ice melting? What could you do instead?

Aerospace Engineering

Aerospace Engineering covers two types of engineering Aeronautical Engineering (anything that flies in the atmosphere) and Astronautical Engineering (anything that flies out of the atmosphere). Aerospace engineers will design and maintain a wide range of aircrafts including aeroplanes, rockets, and hover crafts.

This section has four activities to build objects that will fly through the air:

1. Paper aeroplanes
2. Egg Parachute
3. It's Rocket science
4. Balloon Hover Craft

Paper Aeroplanes

A simple paper aeroplane can fly for the same reasons that aeroplanes fly. As the plane flies, air moving around the wings pushes the plane upwards which counteracts the force of gravity pulling it downwards. Challenge your unit to make different paper aeroplanes and test which ones can travel the furthest, to help you there are some instructions in the resources.

Egg Parachute

In Aerospace Engineering it's not just the flying that's important but also the landing. Controlling the effect of gravity is not just important for safety but also makes sure that passengers have a pleasant flight. In this challenge your unit will need to protect an egg from breaking when it is dropped from height. How you protect your egg is up to you, just make sure that it can survive that impact!

You'll need:

- An egg

Suggestions of other materials that you might like to use are:

- Paper
- Card
- Tape
- Bubble wrap
- Straws

To make the activity harder you can limit the materials that your unit can use or give them a time limit.

There are no rules on how to protect the egg. Once it is ready drop it from height and see if it breaks. (If you'd like to avoid the mess, you could boil the egg first, then look for any signs of cracks on the eggshell).

It's Rocket Science

Aerospace engineers will design and build a rocket so that it will be as aerodynamic as possible so that its rocket fuel can send it further into the atmosphere. Challenge your unit to make their own rockets and launch them using a straw!

You'll need:

- One sheet of A4 Paper (or the rocket template in the resources)
- Pencil
- Tape
- Scissors
- Straw

1. Cut a strip of paper lengthways that is about 5cm wide.
2. Wrap the piece of paper diagonally around the pencil, so that all of the pencil is covered.
3. Secure the tube of paper with tape at both ends and at the middle.
4. Slide the tube off the pencil and trim each end to that it is straight.
5. Fold over one end of the tube and secure it with tape. Make sure to secure it well, as any escaping air could stop your rocket from flying as well!
6. Use the rest of the paper to make a nose cone and fins, then tape them onto your rocket.
    - To make the nose cone you could cut a ¾ circle, then bring one straight edge under the other to make a cone.

7. To launch the rocket, slide it onto the straw then blow as hard as you can through the other end, and see how far it can travel.

    - What happens if we remove the nose cone? Does the rocket fly as far?
    - How could you make the rocket fly further?

Balloon Hovercraft

Flight is caused by the movement of air, that causes lift and forces the object upwards. With this balloon hovercraft, the air has no where else to go expect from under the CD, causing it to push up from the table.

You'll need:

- A CD
- A balloon
- The lid of an old shampoo bottle (the type that you push to open and close)
- Strong tape or glue
- A smooth surface

1. Remove the lid from the shampoo bottle and make sure that it is clean and dry.
2. Tape or glue the lip over the centre hole of the CD. Make sure that it is secure as air that escapes will stop your hovercraft from flying.
3. Close the lids opening.
4. Blow up the balloon.

5. Holding the balloon closed in one hand, stretch the balloon over the lid. Your hovercraft is now ready to test.
6. Place the hovercraft on a flat surface.
7. Gently push the lid open, then give your hovercraft a nudge to start it moving.
8. Watch as your hovercraft glides in the air!

- What would happen if we tried to fly the hovercraft over carpet?
- If you fly the hovercraft again, does it fly as well?
- What would happen if air escaped from around the bottle top?

Software Engineering

Software engineering is a branch of engineering that is rapidly growing. Technology is always advancing, and code is often used to control it. These activities are designed to introduce the idea and structure of code. There are four activities to choose from:

1. Program a leader
2. Flow chart of life
3. Code on a walk
4. Code in nature

Program a leader

When a software engineer writes code, the first version will be written then adapted and improved. This activity is designed to show your unit that writing code is a repetitive process. It's okay if it doesn't work on the first time, because you can keep making changes and keep testing it until it is just right.

For this challenge, each group must write a set of instructions for a leader to follow. This can be made as easy or difficult as you like by changing the task to complete or being more specific with the instructions.

The task that you chose is up to you but could include:

- Make a jam sandwich
- Move a box from one room to another
- Put on a hat, scarf, and gloves

1. Separate the unit into groups and give each group one pen and one piece of paper.
2. Each group must write a set of instructions for the task that you have chosen. Writing each step on a single line.
3. Once they feel that their instructions are complete, they can take it to a leader.
4. The leader will follow the instructions line by line.
5. If there is something missing the group must take their instructions back to their group and adapt it.
6. Steps 3-5 can be repeated until they have a complete set of instructions. The first group that has written complete instructions wins.

Flowchart of Life

Flowcharts can be used to show the basic steps in code and help other people to understand it's function. Flowcharts include boxes with instructions, each different shape has a different meaning. There is an information sheet in the resources showing the different blocks that you can use, and an example flowchart.

In this challenge encourage each girl to draw a flowchart for a task that you might complete in everyday life. This could include washing dishes, riding a bike, or drawing a picture what they choose is up to them.

Think about the different steps involved, when decisions are made and what to do after each outcome.

Code for a Walk

There are many different coding languages that are used by software engineers to program computers. Many of them use very similar statements.

For this activity, ask your unit to use the general code statements in the resources to write code that would describe the walk around your local park. If you're not able to go for a walk you could instead ask them to write code for an everyday task, like the example in the resources section.

Code is all around

Software engineers use code as a language to give computers a set of instructions, however there are many different codes around us, especially in nature.

Go on a walk in your local area and try to spot any codes that you can find.

For example:

- A pedestrian crossing that beeps to tell you to cross
- The different calls that a bird may use when they have found food or when they are in danger
- The number of rings on a tree stump tells us ow old the tree is

Conclusion Challenges

The conclusion challenges are designed to tie the whole badge together and encourage the girls to look back on each of the activities that they have completed. Please complete one of the following four activities.

1. Discussion
2. Encourage others
3. You mean there's more?!
4. Engineering superpowers

Discussion

Complete the badge by giving your unit time to reflect on what they have learnt and discovered about engineering. You could take this time to introduce them into the other engineering sections that you didn't complete activities from. If you haven't already used them, you can use the facts in the resources, or some of the following questions as prompts. If you held a discussion as your introduction activity, please try to choose one of the other conclusion activities.

- Which type of engineering did you enjoy most?
- Have your views on engineering changed?
- If you could do anything, how would you encourage more girls into engineering?

Encourage others

Now that your unit have discovered different some of what the engineering world has to offer, encourage them to spread the message to their friends, family or their peers.

Get them to think of the best way to encourage others, the following list gives a few examples that may give them some ideas.

- Design a poster or leaflet to encourage other girls into engineering.
- Write an article for your local paper covering the activities that you have completed
- Plan activities in groups to celebrate International Women in Engineering Day, and maybe invite another unit along

You mean there's more?!

Ask each girl to research another type of engineering or a specific engineering career. If they're not sure about which career or engineering type to choose, they could also research into different engineering degrees.

Each girl should then share their research with the others. This can be in any form, such as

- presenting to a small group or the rest of their unit
- creating a poster or information sheet
- interviewing an engineer and writing a magazine article

If your unit are stuck for ideas, they may want to investigate into one of the challenge sections that they didn't complete.

Engineering Superpowers

As your unit has experienced each of the challenges, they'll have seen that engineers need a wide range of skills, or superpowers as I like to think of them. Ask the girls to list as many different skills as they can, thinking about all the different activities that they covered.

These could include:

- problem solving
- teamwork
- manual dexterity
- forward thinking
- communication skills
- design
- imagination

Then complete the superpower challenges in the resources to test your unit's superpowers. Each one is short and designed to take less than five minutes. They cover problem solving, teamwork, manual dexterity, and communication.

- Which group was fastest?
- Where any of the challenges easier?
- What helped you to work better as a team?

Badge Order Form

Thank you for completing the Engineering Challenge badge! I really hope that you enjoyed it, if you have any feedback good or bad, I would really love to hear it. You can email it to me at girlscanbeengineerstoo@gmail.com.

Please fill in the following form to order badges, and if possible, please include a Badge Questionnaire, this will really help me to show the results of my Queen's Guide Award project. You can complete the questionnaire as a group or ask each girl to complete one individually.

Unit Name			
District			
Leader's name			
e-mail address (in case there is an issue with the order)			
Address to post badges to			
Number of badges (£1 each)		X £1	=
Postage and packing (1-10 badges = £1, 11-30 badges = £2, 30+ badges = £3)			
Total amount			

Please post the form, with a cheque payable to "St. Anne's Guides", to

Girls Can be Engineers Too!
Croft Holm
New Market Street
Buxton
Derbyshire
SK17 6LP

Please note that cheques will be paid in fortnightly, and badges posted weekly. If you need the badges sooner, please email me (girlscanbeengineerstoo@gmail.com) and I'll do my best to help.

Badge Questionnaire

Well done on completing the Girls can be Engineers Too! Challenge! I really hope that you've enjoyed it. Please could you answer these questions so that I can find out if you've learnt more about engineering, by completing this badge. If you have any comments, please write them on the back of the sheet.

Danielle (Badge creator)

1	I have enjoyed completing this badge	Yes	No
2	Before completing this badge, I knew what engineering was	Yes	No
3	By completing this badge, I have learnt more about engineering	Yes	No
4	Before completing this badge, I knew that there were different types of engineering	Yes	No
5	By completing this badge, I have learnt more about the different types of engineering	Yes	No
6	Before completing this badge, I had considered a job in engineering	Yes	No
7	After completing the badge, I would consider a job in engineering	Yes	No
8	I was surprised by the low percentage of women in engineering (in 2018 only 12 of every 100 engineers were female)	Yes	No
9	I think that there should be more women in engineering	Yes	No
10	I think that girls should be encouraged into STEM (Science, Technology, Engineering and Maths) subjects	Yes	No

Badge Approval

Branding Matters <brandingmatters@girlguiding.org.uk>
To: danielle_watson

Fri, 12 Feb at 15:58

Hi Danielle,

Many thanks for your email and for sharing your badge design. I can confirm this meets our branding requirements and is OK to produce.

Thanks,

Maria

Show original message

Girlguiding
17-19 Buckingham Palace Road
London
SW1W 0PT

Tel: 020 7834 6242
girlguiding.org.uk

Donate to Girlguiding to change the world for girls and young women

Girlguiding is the leading charity for girls and young women in the UK.
We build girls' confidence and raise their aspirations.
We give them the chance to discover their full potential and encourage them to be a powerful force for good.
We give them a space to have fun.

danielle_watson
To: brandingmatters@girlguiding.org.uk

Fri, 12 Feb at 07:55

Good Morning Branding Team,

Please could I have confirmation that this badge fits the Girlguiding badge guidelines.

Thank you very much,

Danielle Watson

St. Anne's Guides, Buxton

67-20 Buxto... .jpg
1.1MB

Resources

In this section are some resources that will help you to complete the activities. They're all split up into the sections to help you find the resources that you need quickly.

Introduction Challenges

Women in Engineering Statistics

12.37% of all engineers in 2018 were female. The number of female engineers is increasing this statistic was 11% in 2017.

46.4% of girls 11-14 would consider a career in engineering, compared to 70.3% of boys.

42.0% of girls 14-16 would consider a career in engineering compared to 66.0% of boys.

25.4% of girls 16-18 would consider a career in engineering compared to 51.9% of boys.

The UK has the lowest percentage of female engineering professionals in Europe, while Latvia, Bulgaria and Cyprus lead with nearly 30%.

In a survey of 300 female engineers in 2013, 84% were either happy or extremely happy with their career choice and two thirds claimed advantages to being a woman in engineering.

Statistics from https://www.wes.org.uk/content/wesstatistics

Different Types of Engineering

Mechanical Engineering

Mechanical engineers study objects and systems in motion, this includes almost every aspect of everyday life including the automotive industry, robotics and manufacturing.

Chemical Engineering

Chemical engineers use a wide variety of materials to create new substances. This could include producing the most efficient car fuel, or producing a new type of plastic, the possibilities are endless.

Software Engineering

Software engineers design software for computer systems, this can include your computer at home or range to software used to control a large machine.

Civil engineering

Civil engineers design and maintain public infrastructure this includes dams, bridges and public roads as well as buildings and even sewage systems.

Electrical Engineering

Electrical engineers design and service electrical equipment and devices. This can include maintaining the national grid or servicing the electrical components of a machine.

Aerospace Engineering

Aerospace engineers generally fit into one of two groups, aeronautical engineering which focuses on flight in atmosphere such as planes and missiles, or astronautical engineers which focuses on space applications where there is no atmosphere.

Items designed or maintained by engineers for Which Engineer? Game

Civil engineering

- Road bridge across a river
- Water transport system
- Tower block

Electronic engineering

- Build a robot
- Equipment in a hospital, such as thermometers and ECG machines (an ECG machine monitors your heartbeat using the electrical signals from your heart)
- Circuit inside your mobile phone

Mechanical engineering

- Engine for a car
- Escalator
- Machines in a factory

Chemical engineering

- New materials e.g. Teflon (a coating used on non-stick pans)
- More efficient fuels
- New types of food that can be taken into space

Aerospace engineering

- Satellite
- Passenger plane
- Jet engine

Software engineering

- Computer games
- Apps on your mobile phone
- Computer program that helps to control a machine in a factory

Famous Female Engineers Bingo Cards

Bingo Card 1

Margaret E. Knight Famous female inventor in 1800s Made improvements to the rotary engine Invented the flat-bottomed paper bag	**Ada Lovelace** 19th century programmer known as the first computer programmer Recognized that the analytical engine could be used as a computer-like device
I am a …….. engineer	**I am a …….. engineer**
Hedy Lamarr Made improvements to plane aerodynamics Developed a method called 'frequency hopping' to help encrypt radio transmitters and receivers during WW2	**Edith Flanagan** Invented a new process for making synthetic emeralds. As well as being used for jewellery they were used to produce powerful microwave lasers.
I am a …….. engineer	**I am a …….. engineer**

Bingo Card 2

Marissa Mayer First female engineer to join Google Went on to become CEO of Yahoo	**Emily Warren Roebling** Instrumental in the construction of the Brooklyn bridge – the first steel wire suspension bridge when it was built in 1883
I am a …….. engineer	**I am a …….. engineer**
Edith Clarke Created the Clarke calculator – a device that used mathematics to calculate how electrical signals could be transmitted through longer distances	**Beatrix Shilling** Served in the Royal Aircraft establishment during WW2 Developed a way to allow spitfires to dive during combat
I am a …….. engineer	**I am a …….. engineer**

Bingo Card 3

Mary Anderson Created the first windscreen wipers – she used a rubber blade attached to a spring-loaded arm that swept across the windscreen	**Stephanie Kwolek** Created Kevlar – a synthetic material that is five times stronger than steel
I am a …….……. **engineer**	**I am a …….…….** **engineer**
Sarah Guppy The first woman to patent a bridge in 1811. Her work helped to build Bristol's Clifton suspension bridge	**Ada Lovelace** 19th century programmer known as the first computer programmer Recognized that the analytical engine could be used as a computer-like device
I am a …….……. **engineer**	**I am a …….…….** **engineer**

Bingo Card 4

Edith Flanagan Invented a new process for making synthetic emeralds. As well as being used for jewellery they were used to produce powerful microwave lasers.	**Edith Clarke** Created the Clarke calculator – a device that used mathematics to calculate how electrical signals could be transmitted through longer distances
I am a …….……. **engineer**	**I am a …….…….** **engineer**
Beatrix Shilling Served in the Royal Aircraft establishment during WW2 Developed a way to allow spitfires to dive during combat	**Lillian Gilbreth** Became the first female member of the American Society of Mechanical Engineers. Worked with General Electric to improve household appliances, such as creating the foot pedal bin, and fridge door shelves.
I am a …….……. **engineer**	**I am a …….…….** **engineer**

Bingo Card 5

Sarah Guppy The first woman to patent a bridge in 1811. Her work helped to build Bristol's Clifton suspension bridge	**Margaret E. Knight** Famous female inventor in 1800s Made improvements to the rotary engine Invented the flat-bottomed paper bag
I am a …….……. **engineer**	**I am a …….…….** **engineer**
Hedy Lamarr Made improvements to plane aerodynamics Developed a method called 'frequency hopping' to help encrypt radio transmitters and receivers during WW2	**Stephanie Kwolek** Created Kevlar – a synthetic material that is five times stronger than steel
I am a …….……. **engineer**	**I am a …….…….** **engineer**

Bingo Card 6

Marissa Mayer First female engineer to join Google Went on to become CEO of Yahoo	**Emily Warren Roebling** Instrumental in the construction of the Brooklyn bridge – the first steel wire suspension bridge when it was built in 1883
I am a …….……. **engineer**	**I am a …….…….** **engineer**
Mary Anderson Created the first windscreen wipers – she used a rubber blade attached to a spring-loaded arm that swept across the windscreen	**Hertha Marks Ayrton** Investigated into electric arcs, helping to understand public lighting in the 1890s. The lights used electricity which arced across two carbon rods, which flickered and hissed as oxygen met the rods.
I am a …….……. **engineer**	**I am a …….…….** **engineer**

Answers

Ada Lovelace - Software

- 19th century programmer known as the first computer programmer
- Recognized that the analytical engine could be used as a computer-like device

Beatrix Shilling - Aerospace

- Served in the Royal Aircraft establishment during WW2
- Developed a way to allow spitfires to dive during combat

Edith Clarke - Electronic

- Created the Clarke calculator – a device that used mathematics to calculate how electrical signals could be transmitted through longer distances

Edith Flanagan – Chemical

- Invented a new process for making synthetic emeralds.
- As well as being used for jewellery they were used to produce powerful microwave lasers.

Emily Warren Roebling - Civil

- Instrumental in the construction of the Brooklyn bridge – the first steel wire suspension bridge when it was built in 1883

Hedy Lamarr - Aerospace

- Made improvements to plane aerodynamics
- Developed a method called 'frequency hopping' to help encrypt radio transmitters and receivers during WW2

Hertha Marks Ayrton - Electronic

- Investigated into electric arcs, helping to understand public lighting in the 1890s. The lights used electricity which arced across two carbon rods, which flickered and hissed as oxygen met the rods.

Lillian Gilbreth - Mechanical

- Became the first female member of the American Society of Mechanical Engineers.
- Worked with General Electric to improve household appliances, such as creating the foot pedal bin, and fridge door shelves.

Margaret E. Knight - Mechanical

- Famous female inventor in 1800s, who made improvements to the rotary engine
- Invented the flat-bottomed paper bag

Marissa Mayer – Software

- First female engineer to join Google
- Went on to become CEO of Yahoo

Mary Anderson - Mechanical

- Created the first windscreen wipers – she used a rubber blade attached to a spring-loaded arm that swept across the windscreen

Sarah Guppy – Civil

- The first woman to patent a bridge in 1811.
- Her work helped to build Bristol's Clifton suspension bridge

Stephanie Kwolek - Chemical

- Created Kevlar – a synthetic material that is five times stronger than steel

Electrical Engineering

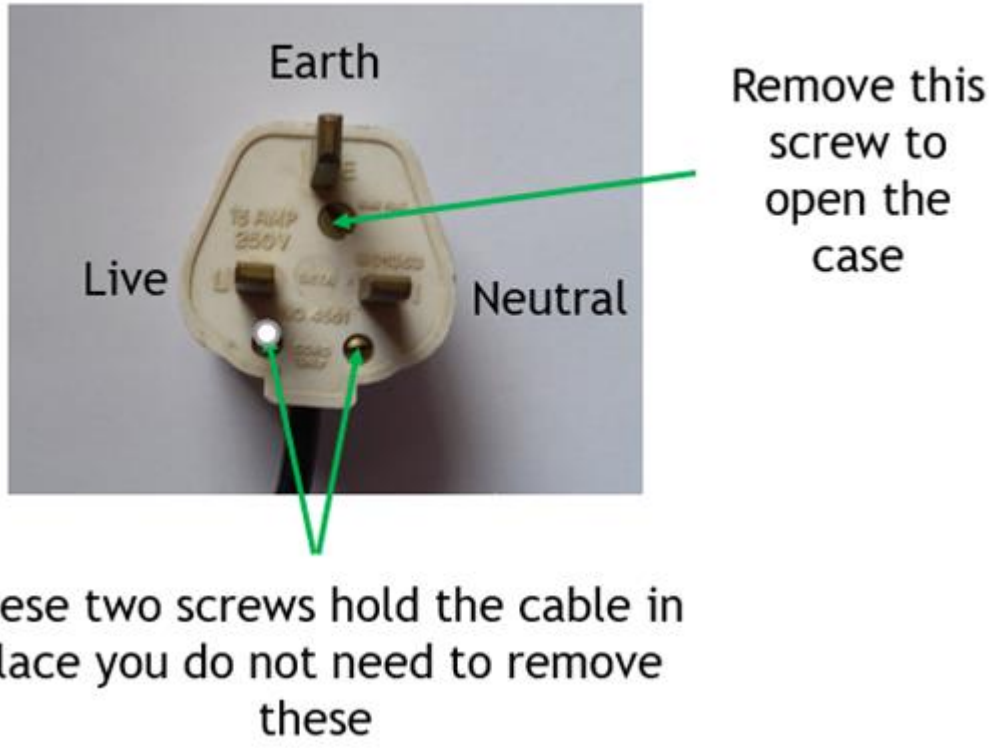
How to wire a plug

In the UK, all mains sockets have three pins, these are:

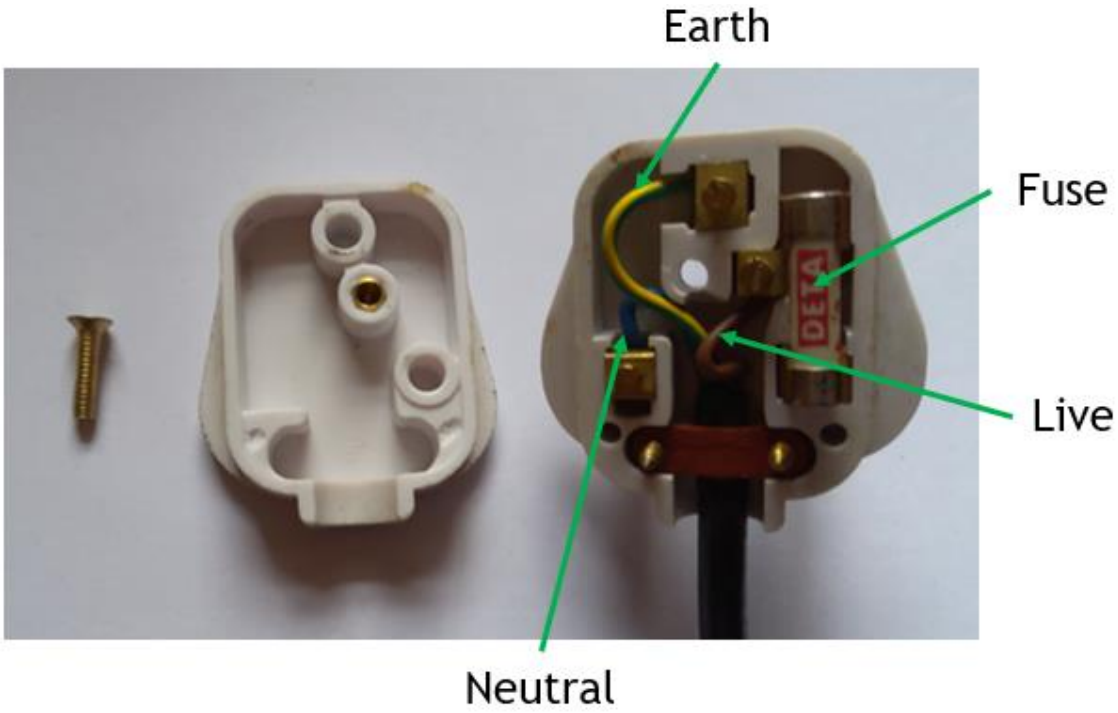
- Live - the incoming electricity supply at 230V AC (alternating current)
- Neutral – the current flowing back out of the appliance
- Earth - A connection to ground, if the electrical object faults, high currents may be produced , which could give you an electric shock. Instead, these would currents would flow to ground.

To take the plug apart and reassemble it, follow these steps.

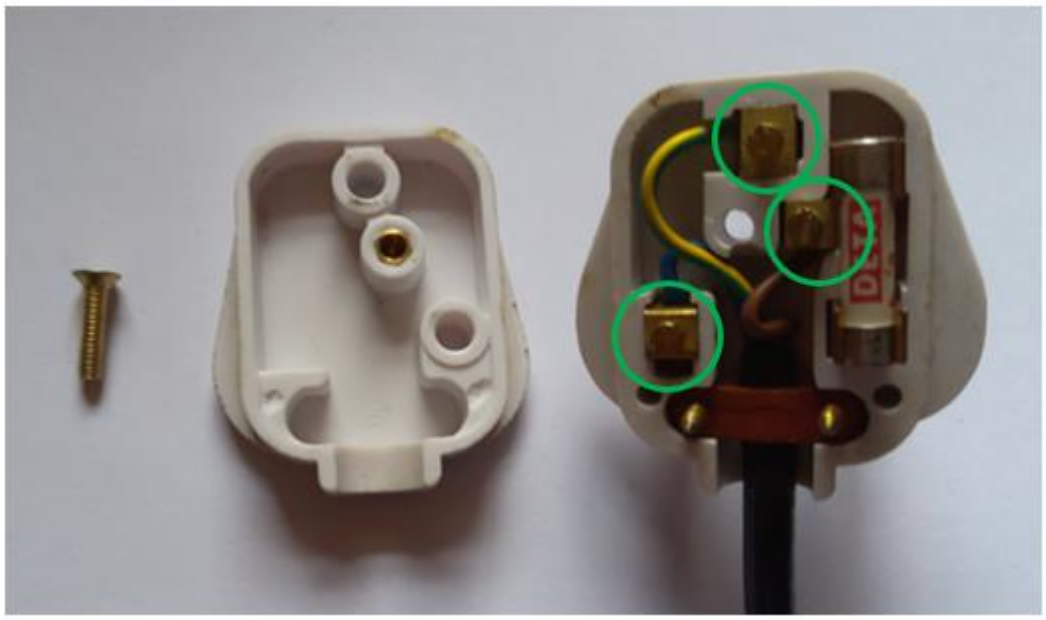
1. Remove any screws holding the case together but leave any screws that are keeping the cable in place.



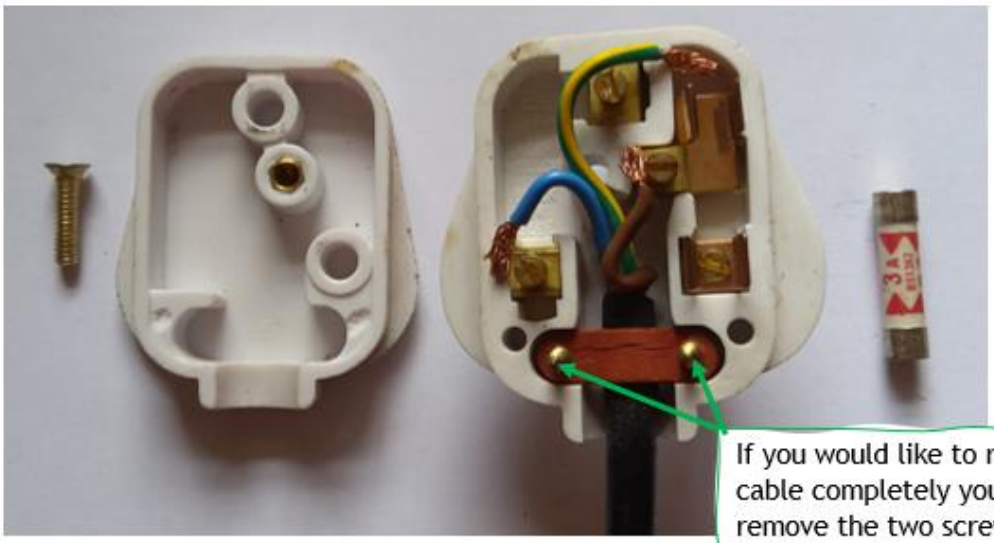
2. Inside you will see three wires of different colours (green/yellow – Earth, brown – Live, blue – neutral), and a fuse. The fuse is added as a safety feature, it contains a small wire inside the glass cylinder. If the current through the wire is too high, the fuse will break and disconnect the circuit.



3. To remove each of the wires loosen the screws that clamp the wire to each pin. You do not need to remove the screw fully but just enough that the wire comes free. You can also remove the fuse by sliding it out of it's holder.

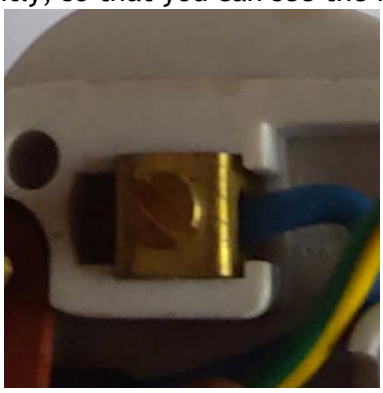


4. After disconnecting the wires, you will see that they are made of copper. Copper is used for lots of conductors, it has lots of electrons that move within the metal to transfer the electric charge.

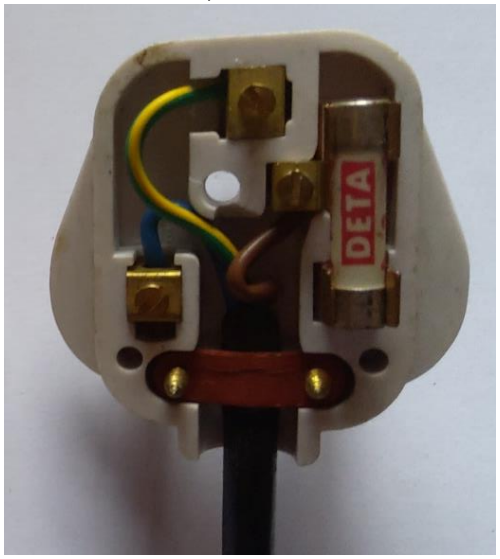


If you would like to remove the cable completely you can remove the two screws that hold the cable clamp in place, and the cable should come free.

5. To put the plug back together, you need to complete the process in reverse. First reattach the wires. There is a hole in each pin that they fit into, then use the screw on the top to tighten it into place. Each wire should push down into the sunken areas. If you are struggling to get the wire into the pin, it may help to push the pin out of the case slightly, so that you can see the hole more easily.



6. Next push the fuse back into its holder, and make sure that everything is secure.



7. Finally, attach the two sides of the casing together with the screw. Well done! You have taken apart and reassembled a plug!

Circuit Pairs

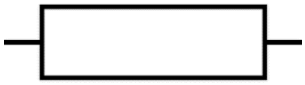
Cards without symbol names

Diode

Only lets current through in one direction.

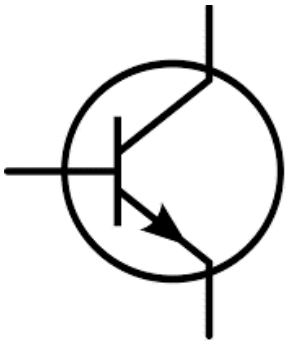
Resistor

Resists the flow of electricity. It is used to reduce the current flowing through a circuit.



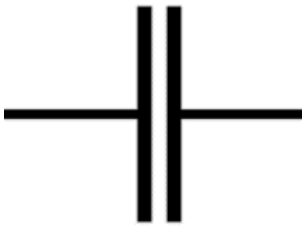
Transistor

When electricity is supplied to the connection on the left, electricity flows from the top to the bottom.



Capacitor

Stores electricity between the two plates.

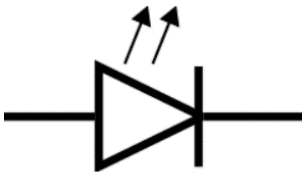


Inductor

A coil of wire. A magnetic field is generated when electricity travels through it.

LED

A Light Emitting Diode. It lights up when current passes through it, from positive to negative.

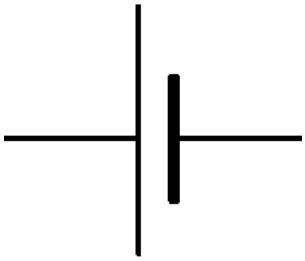


Switch

Can be opened to stop break the circuit and stop the flow of electricity.

Cell

Provides voltage supply to a circuit.



Battery

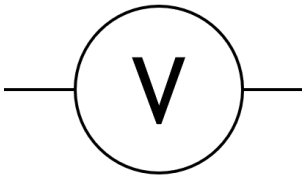
A power supply formed of two or more cells.

Lamp

Lights up when electricity passes through it, in either direction.

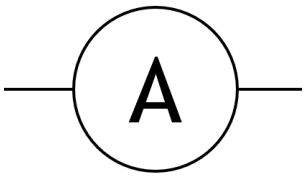
Voltmeter

Measures the voltage across an electrical part.



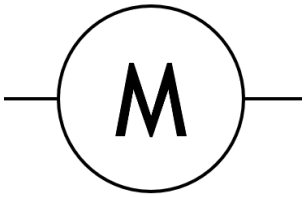
Ammeter

Measures the current that travels through an electrical part.



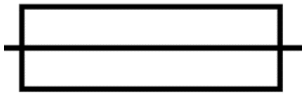
Motor

Spins when it is supplied with electricity.



Fuse

A wire held inside a glass cylinder. It is designed to break if the current in a circuit is too high.



Buzzer

Vibrates when supplied with electricity, producing a sound.

Cards with symbol names

Diode

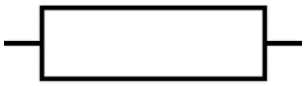
Only lets current through in one direction.

Diode

Resistor

Resists the flow of electricity. It is used to reduce the current flowing through a circuit.

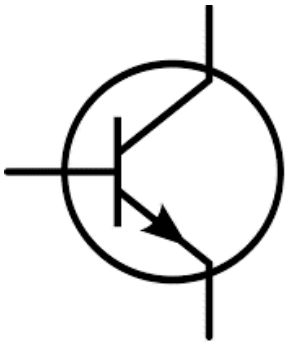
Resistor



Transistor

When electricity is supplied to the connection on the left, electricity flows from the top to the bottom.

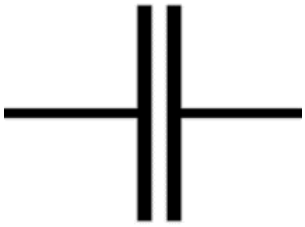
Transistor



Capacitor

Stores electricity between the two plates.

Capacitor



Inductor

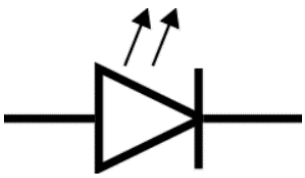
A coil of wire. A magnetic field is generated when electricity travels through it.

Inductor

LED

A Light Emitting Diode. It lights up when current passes through it, from positive to negative.

LED



Switch

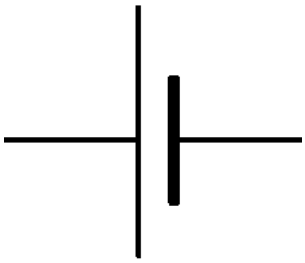
Can be opened to stop break the circuit and stop the flow of electricity.

Switch

Cell

Provides voltage supply to a circuit.

Cell



Battery

A power supply formed of two or more cells.

Battery

Lamp

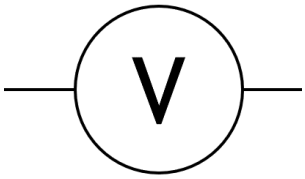
Lights up when electricity passes through it, in either direction.

Lamp

Voltmeter

Measures the voltage across an electrical part.

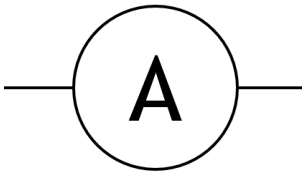
Voltmeter



Ammeter

Measures the current that travels through an electrical part.

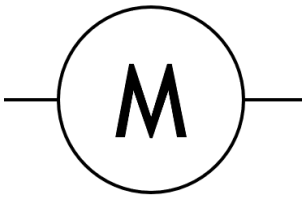
Ammeter



Motor

Spins when it is supplied with electricity.

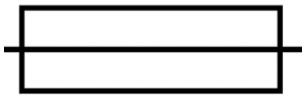
Motor



Fuse

A wire held inside a glass cylinder. It is designed to break if the current in a circuit is too high.

Fuse



Buzzer

Vibrates when supplied with electricity, producing a sound.

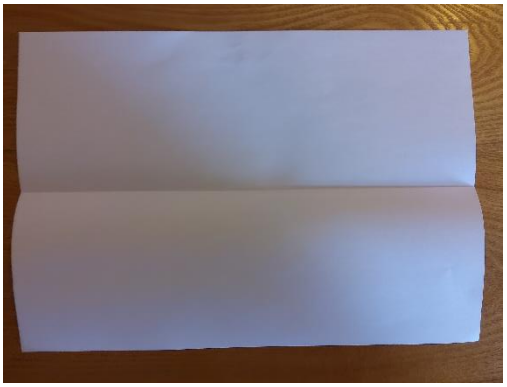
Buzzer

Aerospace Engineering Challenges

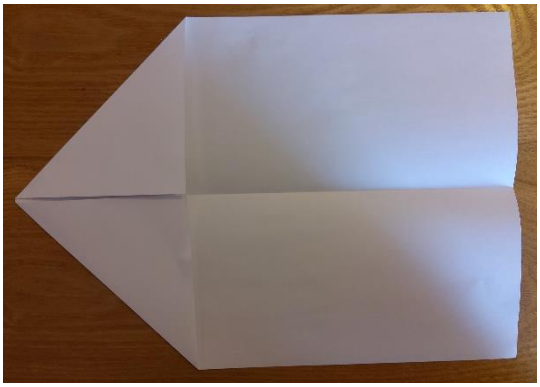
Paper Aeroplanes

Paper Aeroplane 1

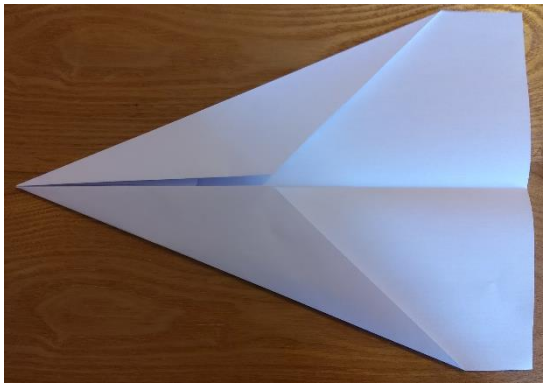
1. Fold your paper in half lengthways and unfold it



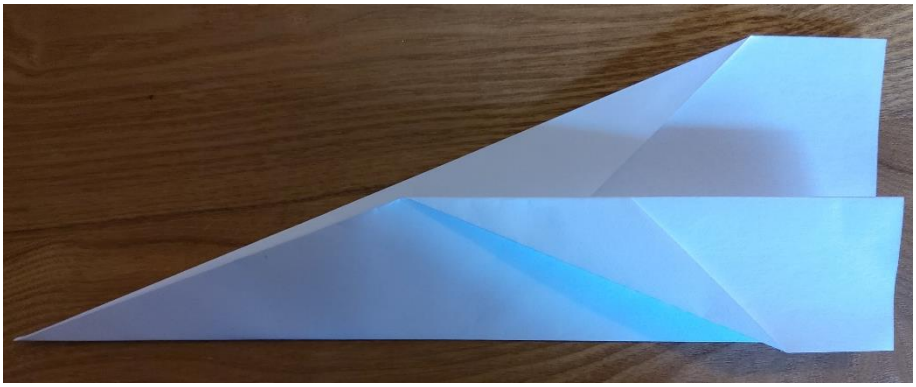
2. Fold two of the corners down to meet the centre fold



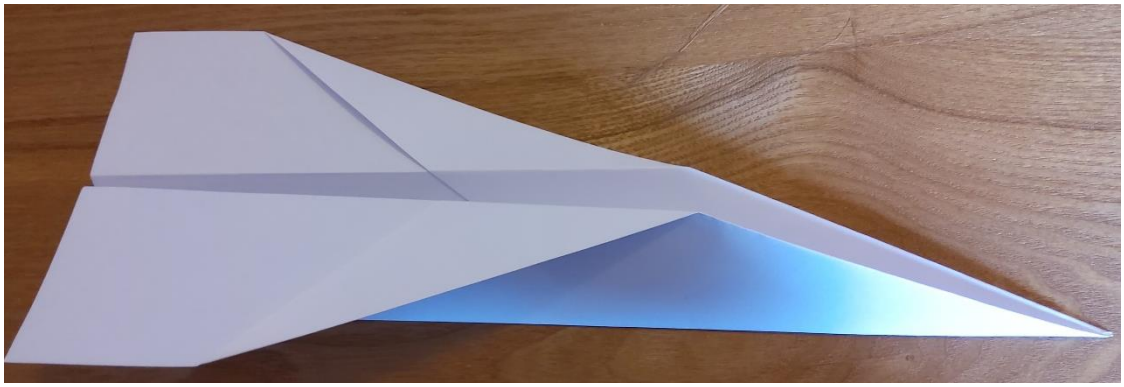
3. Repeat Step 2 again



4. Fold the plane in half then fold each wing down to the centre fold.

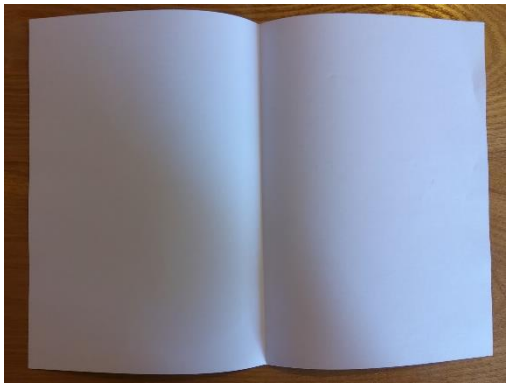


5. Well Done! You've made your paper aeroplane

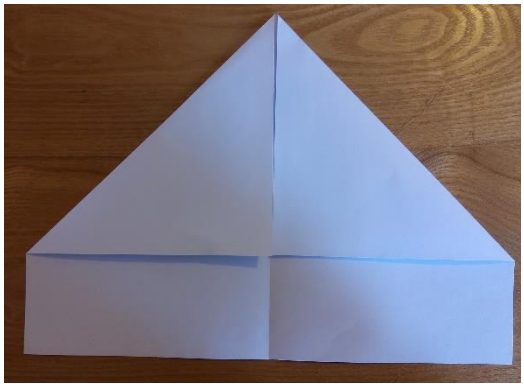


Paper Aeroplane 2

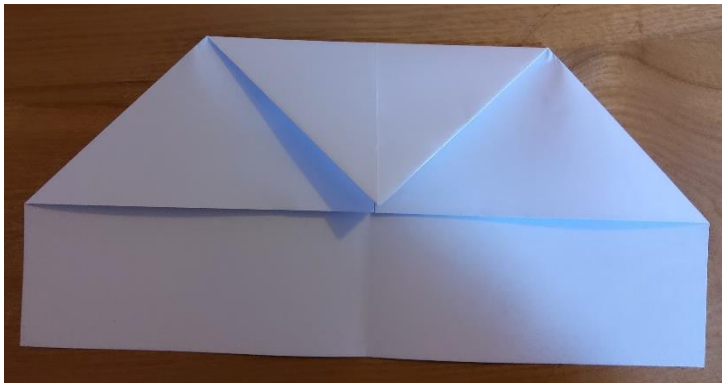
1. Fold you paper in half widthways and unfold it



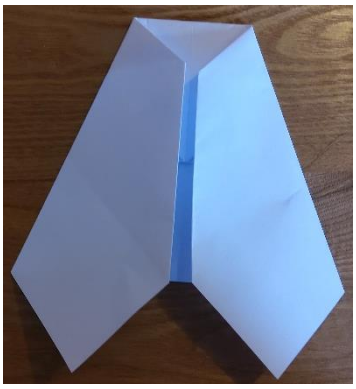
2. Fold each corner to the centre line



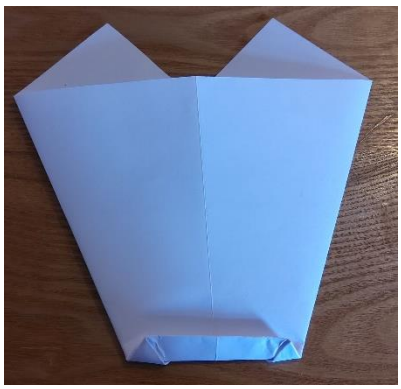
3. Fold the point down to meet the other two corners



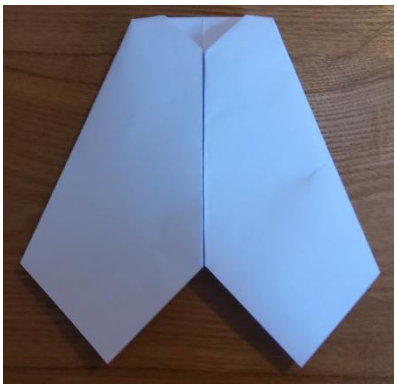
4. Fold the diagonal edges so that they meet at the centre



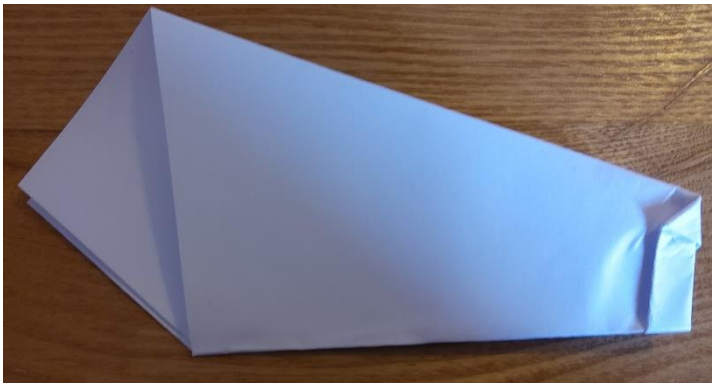
5. Turn the paper aeroplane over and fold the straight edge over by about 1cm



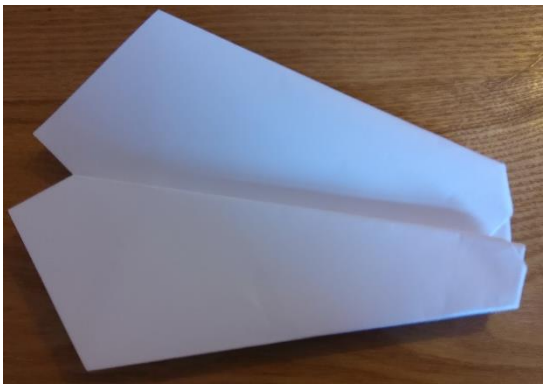
6. Turn the paper aeroplane back over



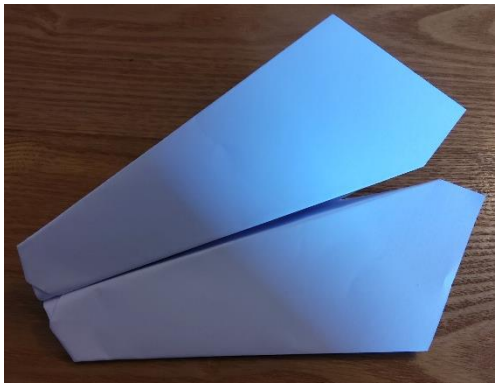
7. Fold the paper aeroplane in half



8. Fold each wing down so that the body is 1cm at the tip of the aeroplane

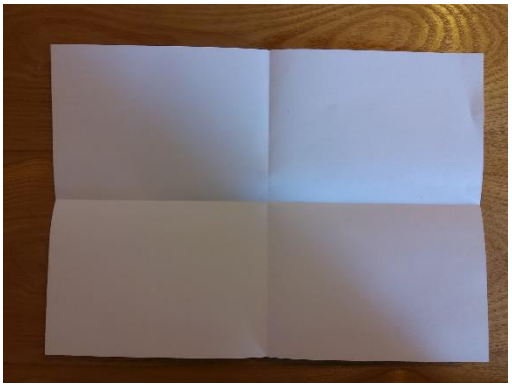


9. Well done! You've made your paper aeroplane. (If your paper aeroplane doesn't stay together very well, you can use a paperclip to hold the centre closed!)

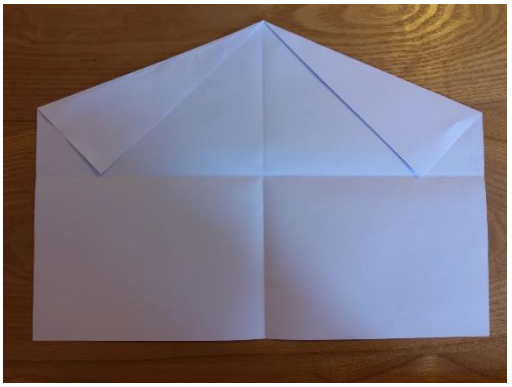


Paper Aeroplane 3

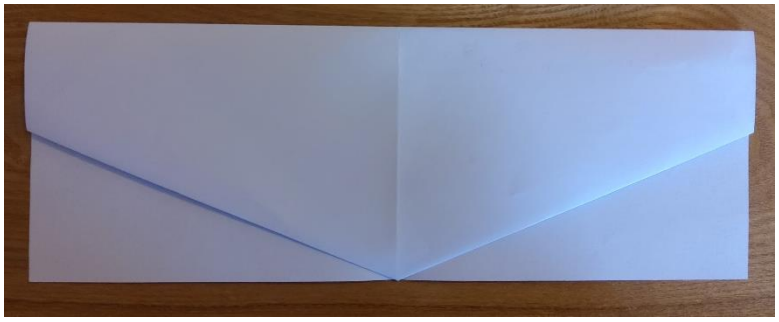
1. Fold the paper lengthways, and unfold it, then fold the paper widthways and unfold it



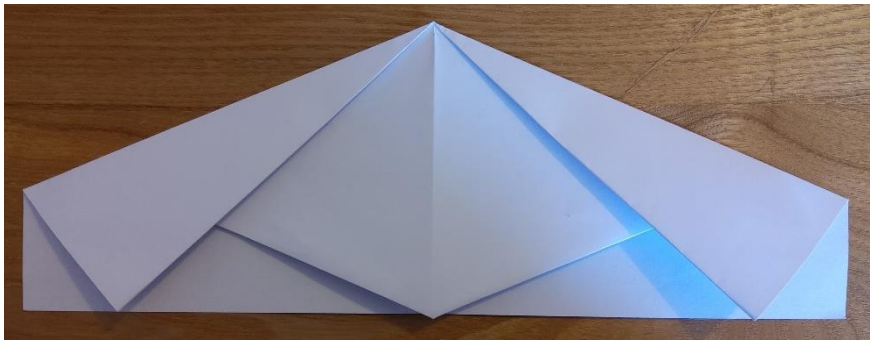
2. Fold down two corners to meet the centre horizontal line



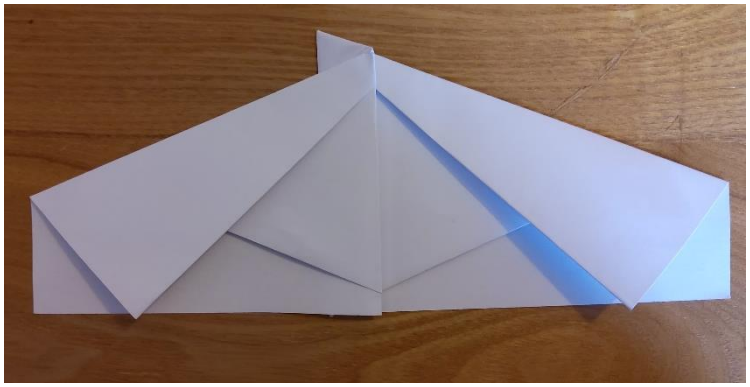
3. Fold the point down to meet the bottom edge



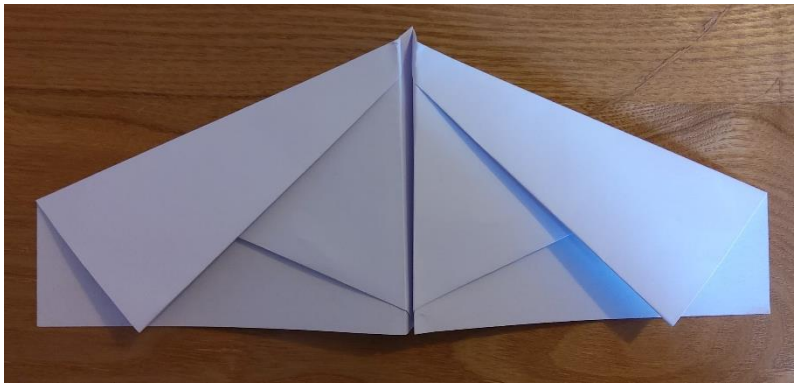
4. Fold down both corners to meet the bottom edge



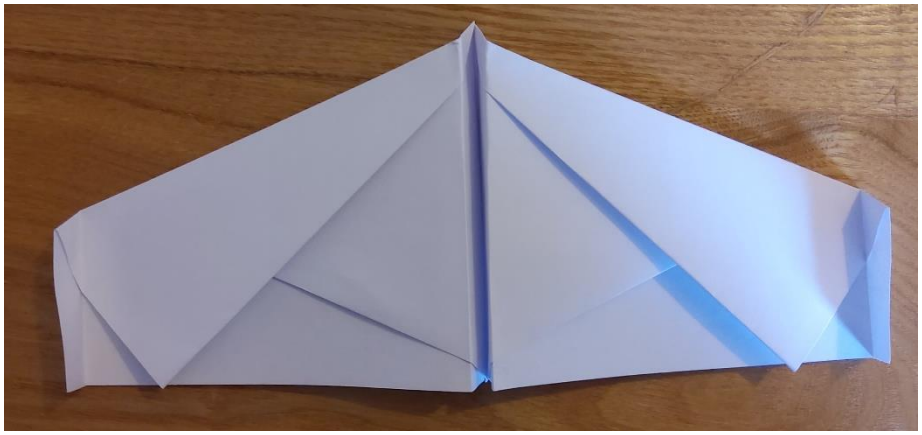
5. Fold the plane in half, then fold down each wing, so that the body is about 2cm in depth



6. Your paper aeroplane should look like this

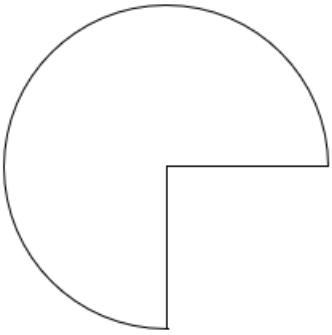


7. Fold the wings in by 2cm on each edge. The flaps should stand upright

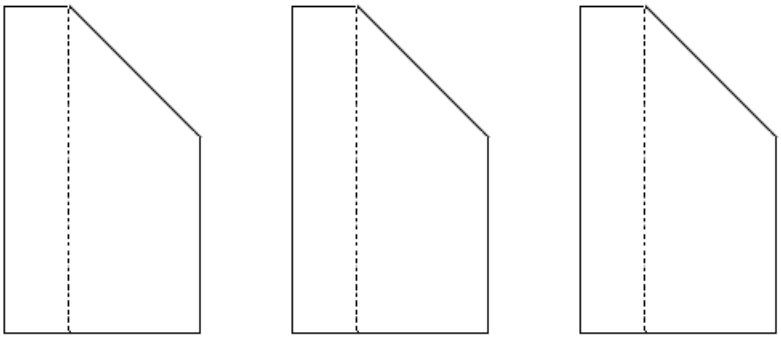


8. Well done! You've completed your paper aeroplane!

Rocket Template



Nose cone



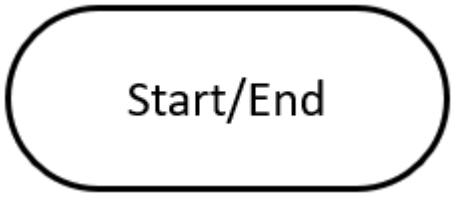
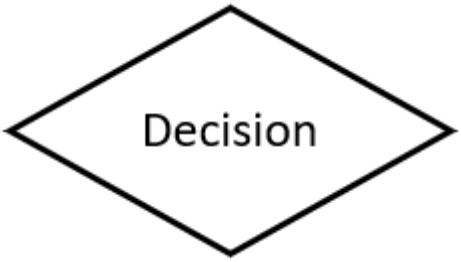
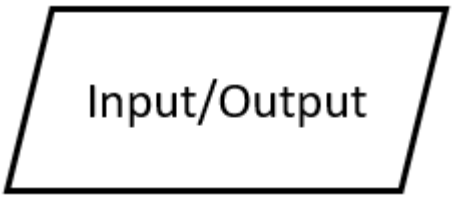
Fins – Fold along the dotted line

Use this strip for the rocket's body

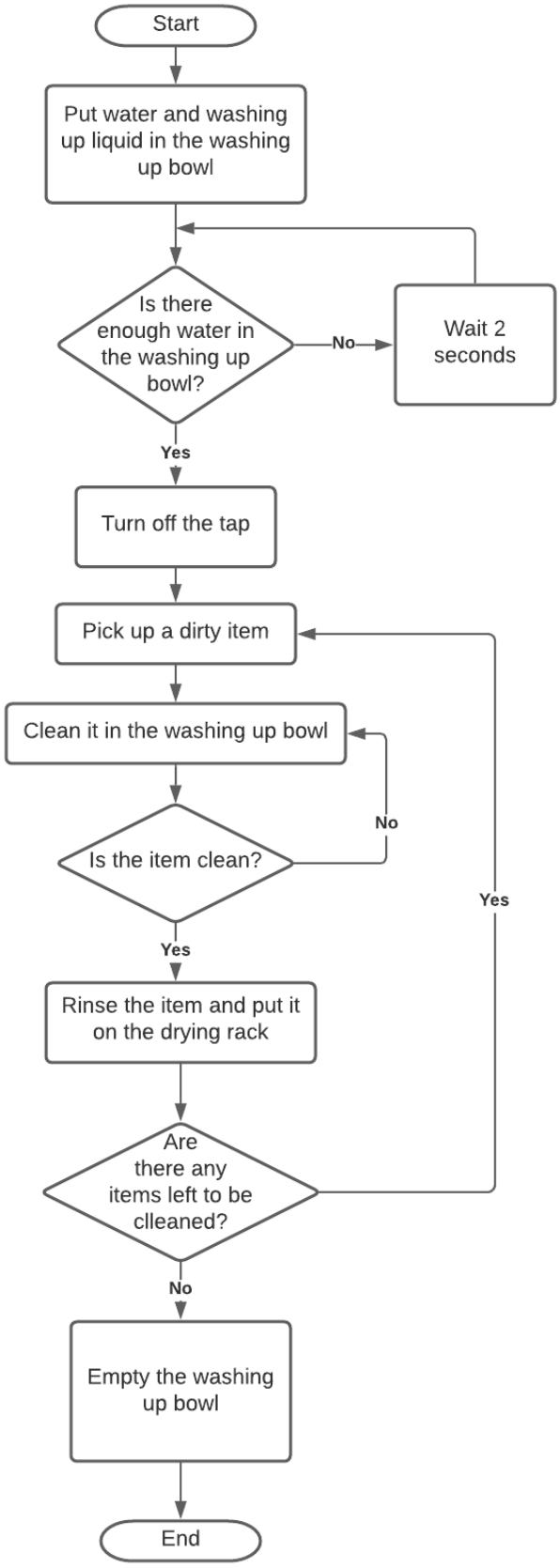
Software Engineering Challenges

Flowchart of Life

Flowchart Blocks

	The start/end block signals the start and end of the flowchart. The flowchart will start at the start block and only stop once the end stop is reached.
	Any step that must be actioned is a process.
	Arrows connect each of the different blocks once a process is complete, the flowchart follows the arrow to the next block.
	Any question that needs to be answered is included in a decision block. There will be multiple arrows coming from the blocks for different answers.
	Any inputs or outputs are drawn in parallelograms. An input block has one arrow from the input to the block where the input is used. The output block will have one arrow from the block where the output is created to the output block. This shows the flowchart that there is something to record.

Example Flowchart



Code for a walk

How to Write Code

```
number of apples = 5;
```

Code contains a series of statements or lines, each line corresponds to one action and is finished with a semicolon, a bit like our sentences finish with full stop.

```
setup() {
  //The code in this section is only actioned once
}
```

Some programs start with setup code this is performed only once at the very start of the code. The curly brackets mark the start and end of the setup code.

```
loop() {
  //This code runs continuously until the program is turned off
}
```

Once the setup code is complete the loop is performed again, and again and again, until the device is turned off. Curly brackets mark the beginning and end of the loop, once the end is reached the program goes back to the beginning.

General Code Statements

If Statement

```
if(number of apples > 0)
{
  eat one apple;
  number of apples = number of apples - 1;
}
```

If statements ask the program a question if the answer is yes, the code inside the curly brackets is performed. If the answer is no, the code is ignored, and the next line is performed. The code above checks if there is an apple in the fruit bowl, if there is an apple it is eaten and the number of apples decreases by one.

If-else Statement

```
if(number of apples > 0)
{
  eat one apple;
  number of apples = number of apples - 1;
}

else
{
  add apples to the shopping list;
}
```

Sometimes you want specific code to also be performed if the answer is no. In this case you can use an else statement after the if statement. If there are no apples in the fruit basket, apples will be added to the shopping list.

For Loops

```
for(number of apples = 0, number of apples < number of apples needed, number of apples++)
{
  place on apple into the shopping bag;
}
```

A for loop performs the actions in the loop whilst the conditions are met. The loop is performed a certain number of times and defined by a number used in the for loop. First the starting value is set, here the number of apples in the shopping bag is zero. Then the condition that must be met is written. We want apples to be put into the shopping bag until the number of apples equals the number of apples needed, so the for loop must be repeated each time that there isn't enough apples. Each time that the for loop is actioned the number of apples is increased by one (++ is a short way of saying increase by 1).

While Loops

```
while(number of apples in shopping bag > 0)
{
  place apple in fruit bowl;
  number of apples in shopping bag = number of apples in shopping bag - 1;
}
```

While loops are performed whilst the condition in the brackets is satisfied. Once the loop is completed the condition is checked again. If the answer is yes, the code is repeated, or ignored if the answer is no. In the code above, if there are apples in the shopping bag, they are placed into the fruit bowl one by one. Once there are no more apples in the shopping bag, the while loop is exited, and the next line of code performed.

Conclusion Challenges

Superpower challenges

Challenge 1: Problem solving

Problem solving is a skill that is required everyday by an engineer, whether this is to fix a fault on a machine or producing an item to solve an everyday problem. Test your unit's problem-solving skills with these sudoku.

1. Give each girl a copy of the sudoku to complete.
2. The puzzle is completed when each box, row and column has only one of each number.
3. A 4x4, 6x6 and 9x9 sudoku have been included so that you can choose the one appropriate for your unit. Each girl only needs to complete one, however, they can complete more of them if they wish.

4x4 sudoku

To complete the sudoku, you must fill each box with the numbers 1, 2, 3 and 4, so that each number appears only once in the box, columns and rows.

2		3	
4			
			3
3	4		2

Answer

2	1	3	4
4	3	2	1
1	2	4	3
3	4	1	2

6x6 sudoku

		4	5	6	
	2	6	4		
4				3	
	6				5
	4	3	6	5	
		5	3		

To complete the sudoku, you must fill each box with the numbers from 1 to 6 so that each number appears only once in the box, columns and rows.

Answer

1	3	4	5	6	2
5	2	6	4	1	3
4	5	1	2	3	6
3	6	2	1	4	5
2	4	3	6	5	1
6	1	5	3	2	4

9x9 sudoku

1	2	6				4	8	3
9			3	2	4			7
7			8		1	9		5
4	9	2	7	1	6	5	3	
			4		5			
	1	5	2	9	3	7	6	4
3		7	1		2			9
5			6		9			2
2	4	9				1	7	6

To complete the sudoku, you must fill each box with the numbers from 1 to 6 so that each number appears only once in the box, columns and rows.

Answer

1	2	6	9	5	7	4	8	3
9	5	8	3	2	4	6	1	7
7	3	4	8	6	1	9	2	5
4	9	2	7	1	6	5	3	8
6	7	3	4	8	5	2	9	1
8	1	5	2	9	3	7	6	4
3	6	7	1	4	2	8	5	9
5	8	1	6	7	9	3	4	2
2	4	9	5	3	8	1	7	6

Challenge 2: Teamwork

Engineers work with a range of different teams, and good teamwork is essential. This activity with a hula hoop will help to test each group's teamwork.

1. Ask the group to stand in a circle and join hands.
2. Then add the hula hoop into the ring between two girls, so that their arms now link through the hoop.
3. The girls must then climb through the hoop moving it around the circle until it returns to its original position.

Challenge 3: Manual Dexterity

A large amount of an engineer's work involves using their hands, such as tightening bolts on a machine or using highly sensitive equipment. In this activity the girls can test their manual dexterity, finding pasta shapes with or without a blindfold.

You'll need:

- Large mixing bowl
- 6 different shapes of pasta (enough for one different shape for each girl)
- Blindfolds (optional)

1. Start by emptying each bag of pasta into the large mixing bowl and give them a good mix.
2. Assign a different shape of pasta to each girl.
3. They must then find as many of their shape as they can in two minutes. If a girl finds a shape that is not hers it must go back into the bowl.
4. Once the time is up, total how many pasta shapes were found by each team member.
5. If you would like to make this challenge more difficult you could blindfold each girl and give them a minute to feel the shape before starting the challenge.

Challenge 4: Communication

When working with lots of different teams it is crucial that engineers have strong communication. In this activity one girl will be directed along the path by her peers. However, the large group must work out the way to communicate most effectively so that clear instructions are given, whilst listening to everyone in the team.

You'll need:

- Blindfold
- Tape
- Stopwatch (optional)

1. Mark out a path on the ground about two-foot-wide with the tape. Make sure that the tape is fixed securely and would not create a trip hazard. The path can be as complex or straight as you would like.
2. Each team must select one girl to be blindfolded, who will walk along the path, and be directed by the rest of their team members.
3. If the line is tape is crossed, the girl must go back to the beginning. Or you could time each team and add a time penalty for stepping across the line but allow them to continue from where they were.